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# **Sampling Episode Report Princess Cruise Lines Island Princess Sampling Episode 6505**

## **Executive Summary**

**March 2006**

## **EXECUTIVE SUMMARY**

### **Sampling Episode Report for Island Princess**

This Sampling Episode Report describes the sampling and analysis activities to characterize wastewater (graywater and sewage) generated and discharged by the cruise vessel Island Princess while in Alaska waters. This sampling took place from August 28 through September 2, 2004, under the direction of the U.S. Environmental Protection Agency (EPA). The sampling program is part of EPA's data collection effort to evaluate whether to develop wastewater discharge standards, under 33 USC 1901 Note, for cruise vessels authorized to carry 500 or more passengers for hire when operating in the waters of the Alexander Archipelago or the navigable waters of the United States within the State of Alaska or within the Kachemak Bay National Estuarine Research Reserve. EPA will use information from the sampling of this vessel and three other cruise ships in Alaska to characterize wastewater generated and discharged by large cruise vessels with advanced wastewater treatment systems.

EPA selected the Island Princess to characterize the performance of the Hamworthy KSE Ltd. membrane bioreactor treatment system, a wastewater treatment system that uses aerobic biological oxidation followed by ultrafiltration and ultraviolet disinfection. Samples were collected of various graywater sources (galley, laundry, accommodations, and food pulper wastewater); influent to the treatment system (mixed accommodations wastewater and sewage); influent to UV disinfection component of the treatment system; effluent from the treatment system; source water; wastewater treatment residuals (screening solids and wastewater biosludge); and incinerator ash. Most wastewater samples were collected for five consecutive 24-hour sampling periods; food pulper wastewater, treatment residuals, and incinerator ash were collected for a single 24-hour sampling period.

Strap-on ultrasonic flow meters were installed near the sampling locations for the galley wastewater, accommodations wastewater, influent to treatment, and effluent from treatment to collect flow data and to trigger automatic sampling machines.

Various sample collection methods (composite by flow, composite by time, grab, and grab composite) were used depending on the sampling point and analyte. Tested analytes included pathogen indicators (fecal coliform, *E.coli*, and enterococci), classical pollutants, total and dissolved metals, volatile and semivolatile organics, pesticides, polychlorinated biphenyls, and dioxins and furans. Not all samples were analyzed for all target analytes.

The galley wastewater samples showed the largest number of analytes detected among graywater sources and the highest concentrations of several analytes commonly used to measure wastewater strength: all three pathogen indicators, biochemical oxygen demand (BOD<sub>5</sub>), chemical oxygen demand (COD), hexane extractable material (HEM), silica-gel hexane extractable material (SGT-HEM), and total suspended solids (TSS). Laundry wastewater samples had the highest concentration among graywater sources for six analytes, while accommodations wastewater had the highest concentration for five analytes.

Because of water conservation measures onboard cruise ships (such as vacuum toilets), key analytes such as pathogen indicators, BOD<sub>5</sub>, COD, and TSS are found at much higher concentrations in the influent to the Island Princess wastewater treatment system than in typical domestic wastewater. Of the 54 metal analytes tested for, 27 were detected in every influent to treatment system sample. Among the 203 target analytes for volatile and semivolatile organics and pesticides, only 6 were detected in any Island Princess influent to treatment samples, most at concentrations close to their detection limits. Among the 160 polychlorinated biphenyl (PCBs) analytes tested for, 36 were detected in Island Princess influent to treatment samples.

The Island Princess' Hamworthy wastewater treatment system treats only accommodations wastewater and sewage. The system successfully removed almost all pathogen indicators (>99%) and most classical pollutants, metals, and organics. Fecal coliform, a pathogen indicator, was detected in only 1 of the 15 effluent from treatment samples, while enterococci and *E. coli* were each detected in 3 of 15 effluent samples at concentrations close to their detection limits. The treatment system removed almost all BOD<sub>5</sub> (99%), COD (93%), TOC (89%), settleable residue (>99%) and TSS (99%). The treatment system reduced ammonia by 58%, total Kjeldahl nitrogen (TKN, which measures both ammonia and organic forms of

nitrogen) and total phosphorus by approximately 75%, while nitrate/nitrite levels remained relatively unchanged. The treatment system was highly efficient at removing particulate metals, and removed dissolved metals at an average of 37%. The treatment system removed most of the volatile and semivolatile organics to concentrations below detection levels.

The Hamworthy wastewater treatment system generates two types of residual waste: screening solids (from the two screen presses at the beginning of the treatment system) and waste biosludge (excess biological mass from the treatment system's bioreactor). Screening solids are collected and incinerated onboard. Waste biosludge is pumped to a double-bottom holding tank for overboard discharge outside of 12 nautical miles from shore. Most of the analytes detected in the waste biosludge were also detected in the influent to the treatment system. For many analytes, concentrations in the screening solids and waste biosludge exceeded those in the influent to treatment, suggesting that these analytes are removed from the system in these waste streams.

On average, each person generated approximately 41 gallons of treated accommodations and sewage wastewater per person per day.